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Spatial Change of Nitrate Concentrations in an Alluvial Aquifer, Osong area, Korea: Multivariate Geostatistical Approach

Kyoung-Ho Kim[1] · Seong-Taek Yun[1*] · Gi-Tak Chae[1] · Byoung-Young Choi[1] · Kangjoo Kim[2] · Hyoung-Soo Kim[2]

[1]*Department of Earth and Environmental Sciences and the Environmental Geosphere Research Lab (EGRL), Korea University, Seoul 136-701, Korea (email: styun@korea.ac.kr)*
[2]*Department of Environmental Engineering, Kunsan National University, Kunsan, Korea*
[3]*Korea Water Resources Research Institute, Daejeon, Korea*

In South Korea, alluvial aquifers in flood plains seem to be highly vulnerable to nitrate contamination because of large-scale intensive agricultural activities over the land surface. There are site-specific buffer zones in alluvial aquifer where nitrate removal occurs. The development of such zone with the pronounced nitrate removal is considered to be closely related with the properties of aquifer geology (Chae et al., 2002). However, quantitative interpretation on spatial variability of nitrate in an alluvial aquifer is very difficult because of the lack of information concerning the spatial heterogeneity of aquifer properties.

This study was performed in an alluvial setting in Osong area, where old oxbow lakes are remained by the migration of a meandering stream. Fine sediments infill the surface part of the oxbow lake, while sandy material is developed on nearby point bar setting. Hydrochemistry data on alluvial groundwater in the area show a spatial variability of nitrate concentrations and other hydrochemical parameters. Thus, we performed a multivariate statistical interpretation, in order to understand the spatial change of water chemistry in relation to the transport and removal of nitrate in flood plain. We integrated the kriging method with factor analysis (Wackernagel 1995;

Goovaerts, 1997). Multivariate correlation between variables (hydrochemcial parameters) was determined by means of bivariate cross-variograms; the multivariate spatial correlations of variables were conveyed into the coregionalized matrix for specific spatial scales; and then factor analysis based on this matrix was performed to detect multivariate spatial similarities of different variables. The results show that nitrate removal occurs preferentially near the oxbow lakes around the traces of old rivers in flood plain. In addition, spatial change of nitrate concentration is well correlated with redox parameters such as Eh and DO. Thus, we suggest that nitrate removal in a fluvial aquifer predominantly occurs through denitrifiaction or nitrate reduction, which occurs preferentially in the area with silt or clay layers within or around oxbow lakes. The results of this study suggest that oxbow lakes may be an excellent site for artificial recharge of contaminated water.

References

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